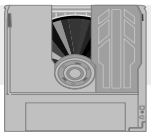
FAA National Software Conference, June 2001
Field-Loadable and User-Modifiable Software

Field-Loadable Software N8110.77/95 and N8110.79/93



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Two Field-Loadable Notices

- **N8110.77/95*** - **"Guidelines for the Approval of Field-Loadable Software"**
- **N8110.79/93*** - **"Guidelines for Approval of Field Loadable Software by Finding Identicality through the Parts Manufacturer Approval Process"**

*** - New numbers assigned**

2

Purpose of Notice .77/.95

- **Purpose:**
  - **To Provide Guidelines for Approving Field-Loadable Software (FLS)**
  - **To Clarify DO-178B FLS Guidance**

3

History of FLS Notices

- **History**
  - **ACSEP Evaluation - May 1997**
  - **FLS Guidance Unclear**
  - **PMA Policy Did Not Specifically Address Software**
  - **Notice Drafted to Address FLS and PMA**
  - **Notice Routed for Comment - Jan. 1998**
  - **Comments Indicated Need for 2 Notices ⇒ N8110.77 and N8110.79**
  - **New numbers assigned - Jan 2001**

4

DO-178B References to FLS

- Field-Loadable Software (FLS) and Loading References:
  - System Design: Sections 2.0 and 2.5
  - SW Process: 6.4.3a., 7.2.1d., e.; 7.2.8, 8.3g.
  - SW Data: 11.1g., 11.2c.(3), 11.4b.(8), (9); 11.10g., 11.11, 11.15, 11.16, 11.20g.

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Notice Outline

- **Section 1: Purpose**
- **Section 2: Distribution**
- **Section 3: Related Publications**
- **Section 4: Definitions**
- **Section 5: Background**
- **Section 6: Earlier Versions of DO-178**
- **Section 7: Approval Information**
- **Section 8: Installation Information**
- **Section 9: Maintenance and Part Marking**

6

Definitions (Section 4)

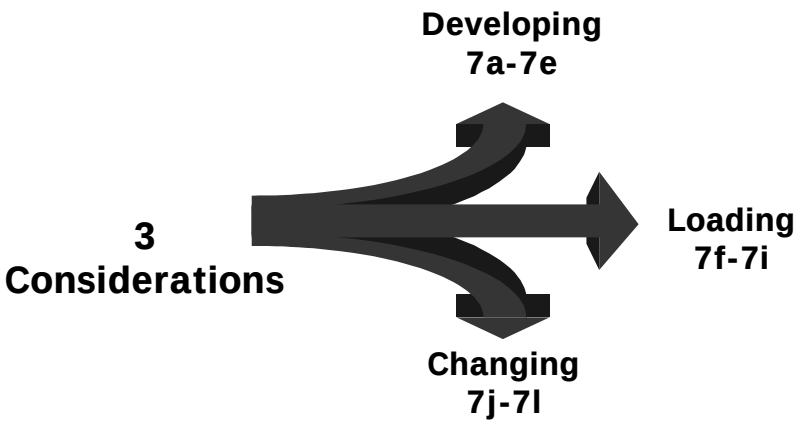
Field-Loadable Software	Software that can be loaded without removal of the equipment from the aircraft installation.
User-Modifiable Software	Software intended for modification by the airplane operator without review by the certification authority, airframer, or equipment manufacturer.
Option-Selectable Software	Software that contains approved and validated components that may be activated by the user.

Examples (Section 4)

- **Field-Loadable Software**
  - **Engine Control Software**
  - **Flight Control Software**
  - **Boeing 777 Has Many Systems With FLS**
- **User-Modifiable Software**
  - **Non-Required, Airline-Specific Electronic Checklists**
- **Option-Selectable Software**
  - **Selection Of Sensors For An FMS**

8

Approval of FLS (Section 7) - 1/4



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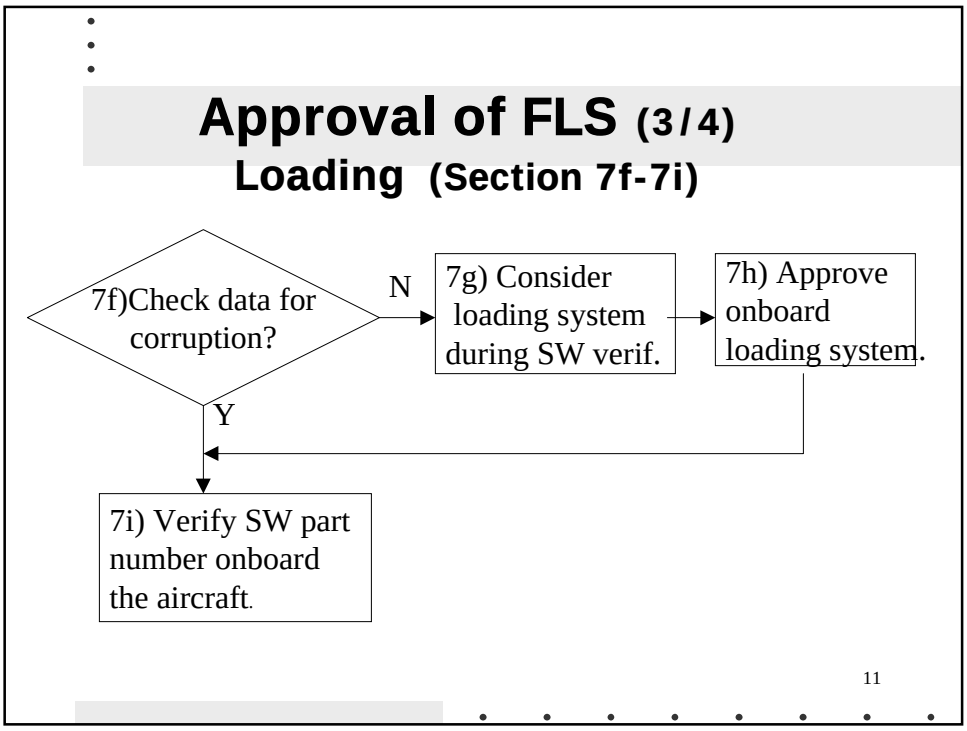
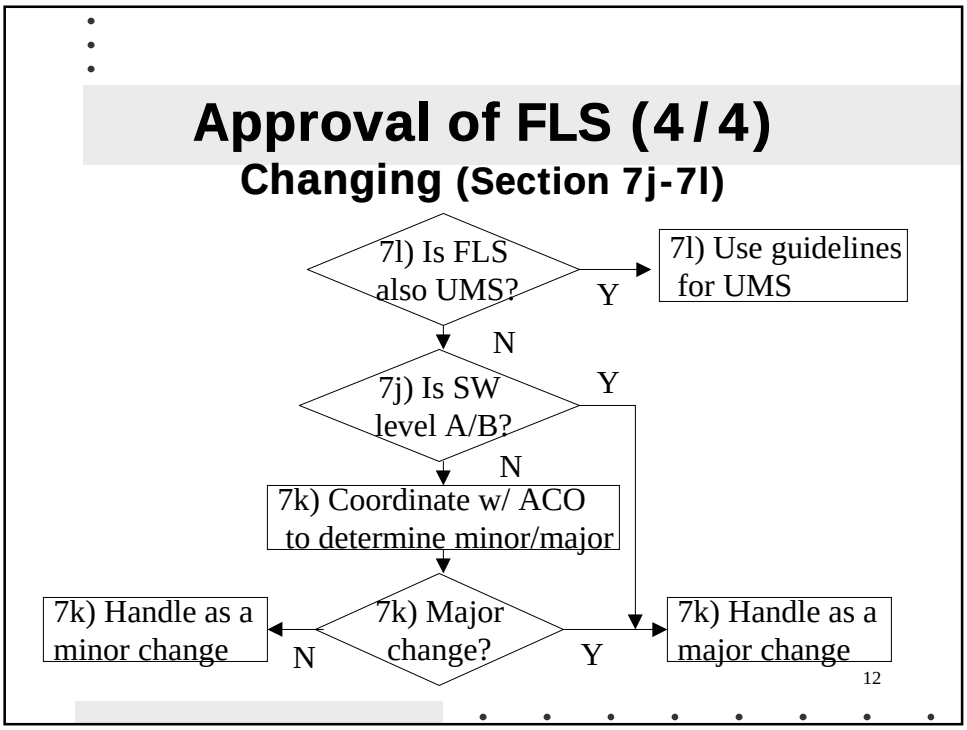
Approval of FLS (2/4)

Developing (Section 7a-7e)

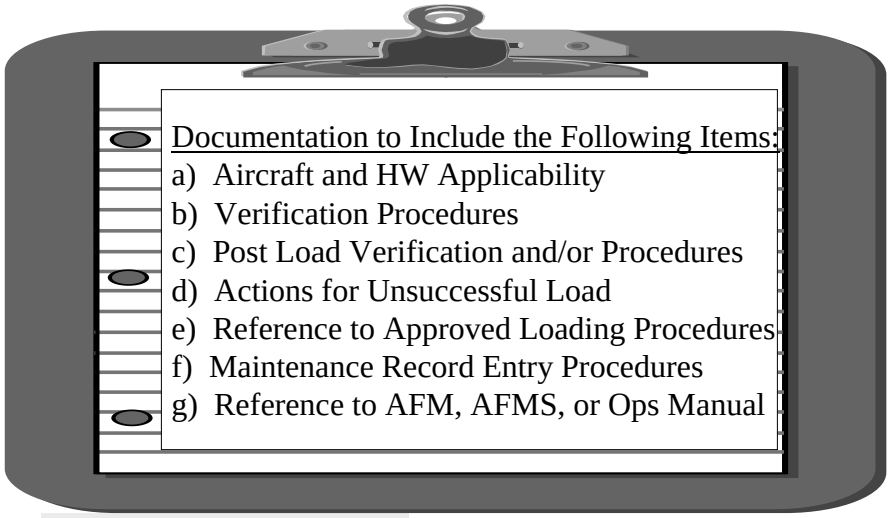
- 7a) Meets 178B Objectives
- 7b) Considers 178B Paragraph 2.5
- 7c) Verify SW on Target HW
- 7d) Configuration Management
- 7e) Considering Redundant Parts

10


Approval of FLS (3/4)
Loading (Section 7f-7i)
7f)Check data for corruption?
N
7g) Consider loading system during SW verif.
7h) Approve onboard loading system.
Y
7i) Verify SW part number onboard the aircraft.
11


Approval of FLS (4/4)
Changing (Section 7j-7l)
7l) Is FLS also UMS?
Y
7l) Use guidelines for UMS
N
7j) Is SW level A/B?
Y
N
7k) Coordinate w/ ACO to determine minor/major
7k) Handle as a minor change
N
7k) Major change?
Y
7k) Handle as a major change
12

Installation of FLS (Section 8)



Maintenance & Part Marking of FLS (Section 9) - 1/2

9a) Maintenance Procedure in Aircraft Maintenance Manual

9b) Procedure to Include Reading of SW Version

9c) Procedure to Include Part Number in Maintenance Records

9f) Changes Reflected in Appropriate Manual or Logbook

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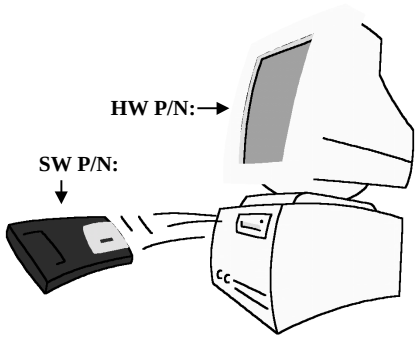
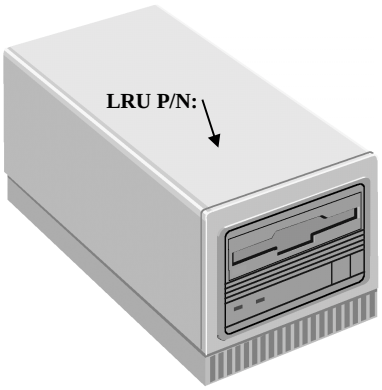
Maintenance & Part Marking of FLS (Section 9) - 2/2



9d) Procedure to Verify SW Load



9e) Procedure to Verify Nameplate & SW Load

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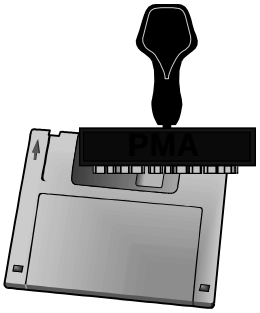
Parts Manufacturer Approval of Field-Loadable Software

N8110.79/93*



* New Number

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Purpose and History

- **PURPOSE OF NOTICE:**
  - **Provides Guidelines for Approving FLS Through PMA**
  - **Limited to Identicality With or Without a Licensing Agreement**
  - **Does Not Cover Test and Computation**
- **HISTORY**
  - **Started As Part of N8110.77 But Was Separated For Clarity**

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Technical Information

- **FLS Is Beneficial to Airlines and Applicants**
- **Order 8110.42, "PMA Procedures," Does Not Specifically Address Software**
- **CFRs 21.301, 303, and 305 Do Not Specifically Address Software**
- **Data Being Loaded Is Approved, Not Media**

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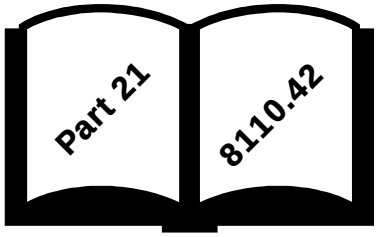
Procedures (Section 5) - 1/2

- Follow Part 21 and Order 8110.42 in Conjunction With the Software-Specific Procedures in N8110.79/93*



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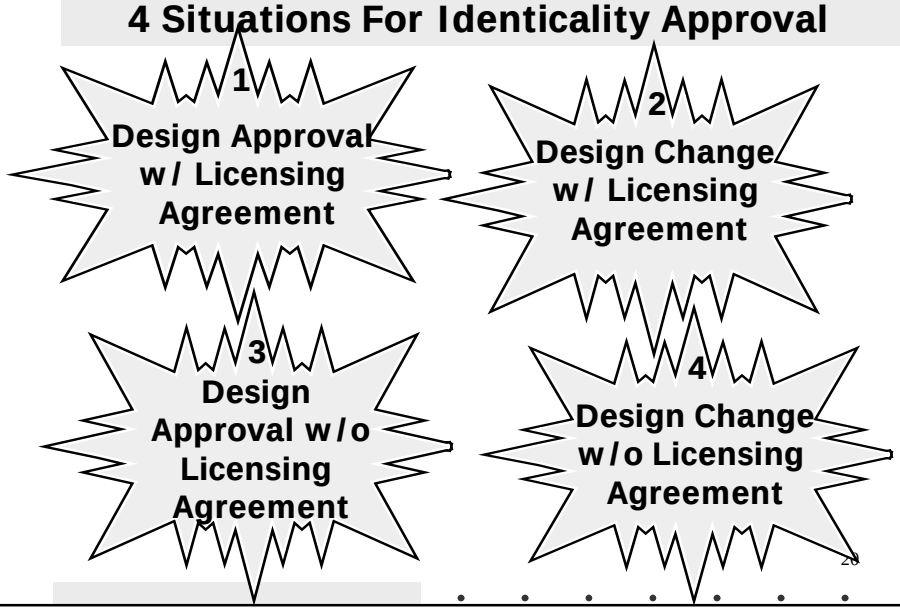
Procedures (Section 5) - 2/2

4 Situations For Identicality Approval



Design Approval: Identicality with Licensing Agreement (Section 5b(1)a)

- Reference 8110.42, 8(a)(3)(a)
- FLS Should Be Approved Through TC, STC, ATC as Described in N8110.77/95*
- FLS Should Be Installed Via Service Bulletin Or Similar Means
- Configuration Management Process Should Be In Place To Assure Software Part Number, Hardware Part Number, Aircraft Series, etc. Are Accurate

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Design Change: Identicality with Licensing Agreement (Section 5b(1)b)

- Reference 8110.42, 8(h)(5)
- Applicant Should Coordinate Change With TC, STC, ATC Holder
- FAA Notice 8110.85 "Guidelines for the Oversight of Software Change Impact Analysis Used to Classify Software Changes as Major or Minor", dated May 11, 2000
- Determine Minor/Major Classification
  - Major change ⇒ 8110.42 8(h)(5)(a)
  - Minor change ⇒ 8110.42 8(h)(5)

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Design Approval: Identicality w/o Licensing Agreement (Section 5b(2)a)

- Order 8110.42, 8(a)(3)(b) - Parts Must Be Identical In "All Respects"
- FLS Should Be Identical To The Software On The TC, STC, ATC Approval
  - Bit-by-bit Comparison
  - Evidence of Identical Type Design Data - DO-178B Section 9.4

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Design Change: Identicality w/o Licensing Agreement (Section 5a(2)b)

- Change Considered Major
- Reference 8110.42, 8(h)(5)(a)

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Summary

- Two Notices Related to FLS
  - N8110.77/95* - Guidelines for Approval of FLS
  - N8110.79/93* - Guidelines for PMA via Identicality for FLS
  - Reference DO-178B, Part 21, and Order 8110.42

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N8110.84/94*
Approval of Airborne Systems and Equipment Containing User-Modifiable Software

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* New number

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Purpose & History

- PURPOSE OF NOTICE
  - To Provide Guidelines To ACO Engineers and DERs For Approval of Systems With User-Modifiable Software (UMS)
  - To Encourage Working With Flight Standards Personnel:
    - Maintenance Inspectors, Avionics Inspectors, and Operations Inspectors
- HISTORY OF NOTICE
  - Started - 1996

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DO-178B References to UMS

- User-Modifiable Software (UMS) References:
  - System Design: Sections 2.0 and 2.4a.-d.
  - SW Process: 5.2.3, 7.2.2b.
  - SW Data: 11.1g., 11.10g., 11.20g.

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Technical Information

Biggest Concerns:

- Corruption of Non-modifiable, Safety-related Software
- Change Control Problems in the Field
- Compelling but Invalid Information in the Cockpit

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Notice Outline - 1/2

- **Sections 1-3: Purpose, Distribution, Related Publications**
- **Section 4: Definitions**
- **Section 5: Scope**
- **Section 6: Earlier Versions of DO-178**
- **Section 7: Safety Considerations**
- **Section 8: Displayed Data**
- **Section 9: Aircraft Performance Parameters**
- **Section 10: Protection**

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Notice Outline - 2/2

- **Section 11: Tools**
- **Section 12: Data Requirements**
- **Section 13: Other Considerations**
- **Section 14: Conclusion**

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Definitions (Section 4) - 1/2

User-Modifiable Software	**Software intended for modification by the airplane operator without review by the certification authority, airframer, or equipment manufacturer.**
Option-Selectable Software	**Software that contains approved and validated components that may be activated by the user.**
Field-Loadable Software	**Software that can be loaded without removal of the equipment from the aircraft installation.**

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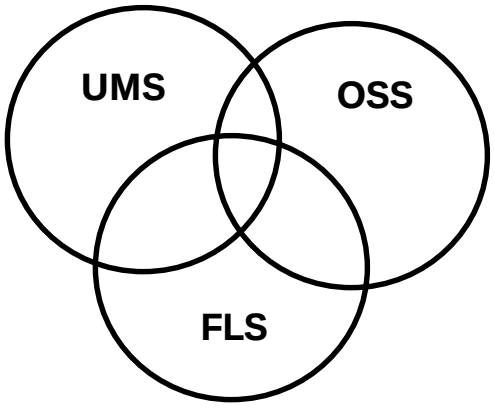
Definitions (Section 4) - 2/2



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Databases, etc?

- What About Navigation or Terrain Databases?
- What About Programmable Waypoints or Other Programmable Database-Like Items?

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Scope (Section 5)

Notice is for User-Modifiable Software Only

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Earlier Version of DO-178 (Section 6)

- Earlier Versions of DO-178 Contain No Guidance for User-Modifiable Software
- Use DO-178B Guidance for The User-Modifiable Portions

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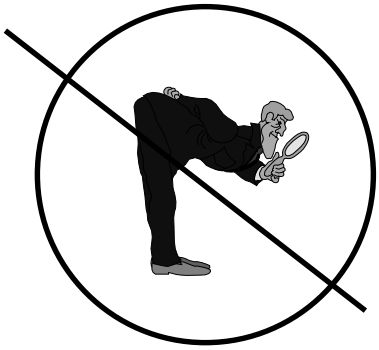
Safety Considerations (Section 7) - 1/3

- Once Certified as UMS There is No Certification Authority Oversight



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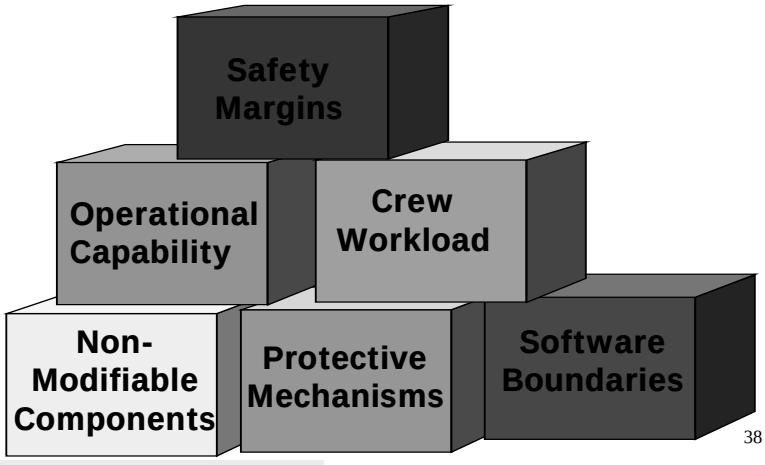
Safety Considerations (Section 7) - 2/3

Modifications Should Have No Effect On



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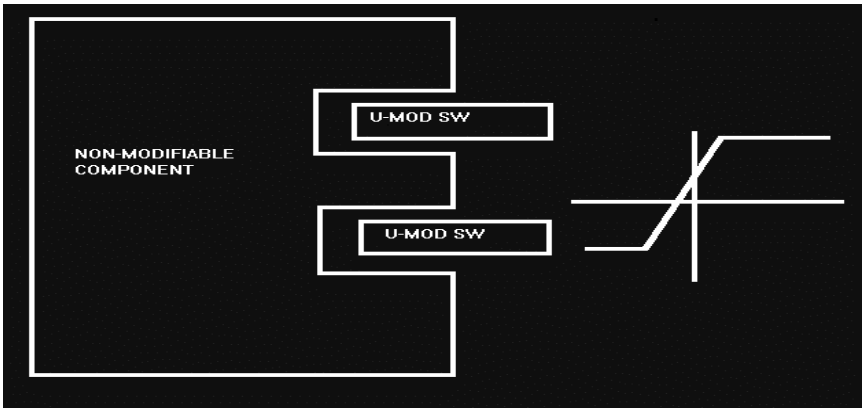
Safety Considerations (Section 7) - 3 / 3

- **Effects Must Be Bounded**



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Identification of Displayed Data (Sec. 8)

- Obvious or Explicit Indication That the Data is Not Cert Authority Approved

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Performance Parameters (Section 9) - 1/2

- Modifications to Provide or Revise Performance Parameters Requires Certification Authority Review and Approval
- Examples of Parameters
  - Safety margins
  - Operational capabilities
  - Crew workload

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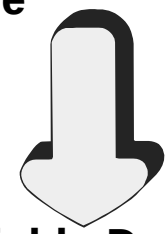
Performance Parameters (Section 9) - 2/2

- Changing Data To Determine Aircraft Performance Parameters = Major Change



- User-Modifiable Designation Lost

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Protection (Section 10) - 1/4

- **UMS Components Shouldn't Affect Non-UMS Components**
- **Assure Protection Is Developed to at Least Same Level of Robustness Required of the Most Robust Non-UMS Component**

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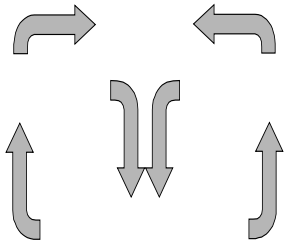
Protection (Section 10) - 2/4

- Two Considerations
  - Operating In:
    - Protection in the design and operation
  - Changing Out:
    - Protection during modification



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Protection (Section 10) - 3/4

- Examples
  - Partitioning
  - Hardware Modes
  - Encoding
  - Tools
    - Modifications
    - Loading Protection (CRC)

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Protection (Section 10) - 4/4

Protect Against Breaches

- Accidental Breach
  - Low Likelihood Under Reasonably Probable Circumstances
  - (Subjective statement of probability - not a xx.1309 definition)
- Intentional Breach
  - Low Likelihood Without Undue Effort

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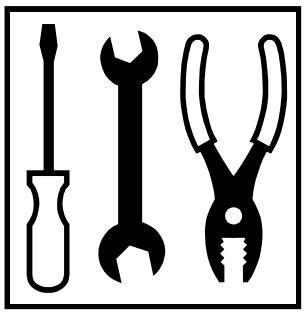
Tools (Section 11) - 1/4



- **Used to Enforce Protection**
  - **Not DO-178B Qualified Tools?**
- **Demonstrated As the Only Means To Modify UMS Component**

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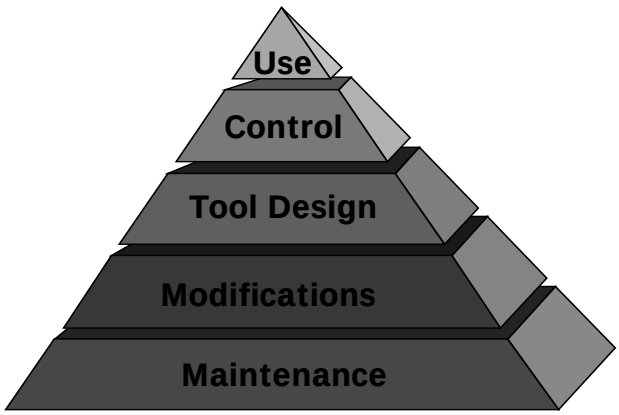
Tools (Section 11) - 2/4

Requires Review and Approval Of:



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Tools (Section 11) - 3/4

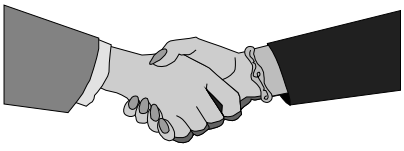
Design Approval of Tools

By ACO Engineer

49

Tools (Section 11) - 4/4

Maintenance Approval of Tools



Jointly By:
ACO Engineer
Operational Authority
Maintenance Authority

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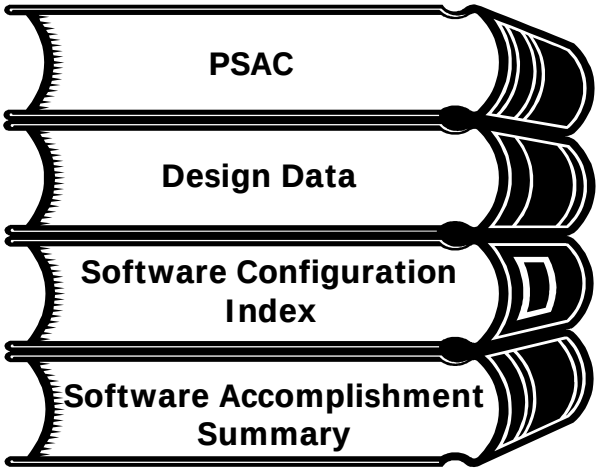
Data Requirements (Section 12)



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Other Considerations (Section 13)

- User Follows the Approved Procedures for Modifications to UMS
- User Responsible for Configuration Management, Quality Assurance, and Verification of the Software
- Changing Anything Besides UMS Can Result in Certificate Being Rescinded

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Summary

- N8110.84/94* Provides Guidelines For Approval of Systems & Equipment Containing UMS
- Provides Guidelines On:
  - Safety Considerations & Safety Parameters
  - Protection
  - Tools
  - Data Requirements
  - Working With FSDO Personnel

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